PICO CELL-SELECTION/HANDOVER FOR TDM EICIC HETEROGENOUS NETWORKS

FIELD OF THE INVENTION

[0001] The present invention relates to an apparatus, a method, a system, and a computer program product related to improving the handover and/or cell selection. More particularly, the present invention relates to an apparatus, a method, a system, and a computer program product for improved handover and/or cell selection in heterogeneous networks.

BACKGROUND OF THE INVENTION

Abbreviations

[0002] 3GPP 3rd generation partnership project

ABS Almost Blank Subframe

CRE Cell Range Extension

[0003] eICIC enhanced Inter-Cell Interference Coordination

eNB Evolved Node B

LTE Long Term Evolution

PUE Pico User Equipment

RSRP Reference Signal Received Power

RSRQ Reference Signal Received Quality

TDM Time Domain

[0004] TS Technical specification

[0005] Cell-selection/handover methods in heterogeneous networks (HetNet) with co-channel deployment of macro-eNBs and pico-eNBs, in particular with Time Domain (TDM) enhanced Inter-Cell Interference-Coordination (eICIC) may be improved.

[0006] In conventional macro-cell networks, UE cell selection/handover is typically based on UE measurements of Reference Signal Received Power (RSRP). However, applying this criterion to HetNets leads to a downlink imbalance problem: the coverage of the macro-cell is much larger than that of the pico-cell due to the difference in transmission power between both layers. However, the RSRP-based cell selection can be adapted to HetNets by adding a positive bias (Cell Range Extension CRE) to the received RSRP value in order to balance the load macro-pico. Thus, RSRP+CRE-based cell selection makes the UE to select the cell with highest RSRP+CRE value, where CRE is equal to zero for macro-cells and positive for pico-cells.

[0007] As shown in the baseline scenario in FIG. **1**, the footprint (coverage area) of the pico-cell is expanded by the application of the CRE offset. To protect a victim pico UEs (PUEs=a UE served by the pico eNB) in the extended area from severe interference from macro layer, the macro eNB is prevented from transmitting on certain subframes, called Almost Blank Subframes (ABS).

SUMMARY OF THE INVENTION

[0008] It is an object of the present invention to improve the prior art.

[0009] According to a first aspect of the invention, there is provided an apparatus, comprising first cell range extension checking means adapted to check if a first received cell range extension received from a first cell is larger than 0; second cell range extension checking means adapted to check if a second received cell range extension received from a second cell is larger than 0, wherein the second cell is different from the first cell; setting means adapted to set, if both the first received cell range extension and the second received cell range extension are larger than 0, a first modified cell range extension based on the first received cell range extension and a second modified cell range extension based on the second received cell range extension, wherein for at least one combination of values of the first and second received cell range extensions at least one of the first and second modified cell range extensions is different from the respective received cell range extension, and to set, if at least one of the first received cell range extension and the second received cell range extension is equal to 0, the first modified cell range extension equal to the first received modified cell range extension and the second modified cell range extension equal to the second received cell range extension; selecting means adapted to select one of the first cell and the second cell for cell selection and/or handover based on a comparison of a sum of a first signal strength indicator from the first cell and the first modified cell range extension and a sum of a second signal strength indicator from the second cell and the second modified cell range extension.

[0010] The apparatus may further comprise attaching means adapted to attach the apparatus to the cell selected by the selecting means.

[0011] In the apparatus, the first and second signal strength indicators may be respective reference signal received powers or the first and second signal strength indicators may be respective reference signal received qualities.

[0012] In the apparatus, the setting means may be adapted to set, if both the first received cell range extension and the second received cell range extension are larger than 0, the first modified cell range extension and the second modified cell range extension such that an absolute value of a difference between the first modified cell range extension and the second modified cell range extension is not larger than a threshold.

[0013] The apparatus may further comprise comparing means adapted to compare which of the first received cell range extension and the second received cell range extension is the larger one; and the setting means may be adapted to set, if the first received cell range extension is not smaller than the second received cell range extension, the first modified cell range extension equal to the minimum among the first received cell range extension and a sum of the second received cell range extension and the threshold, and to set, if the first received cell range extension is smaller than the second received cell range extension, the second modified cell range extension equal to the minimum among the second received cell range extension and a sum of the first received cell range extension and the threshold.

[0014] In the apparatus, the threshold may be 0.

[0015] In the apparatus, the setting means may be adapted to set, if both the first received cell range extension and the second received cell range extension are larger than 0, the first modified cell range extension equal to a the first received cell range extension multiplied by a factor and the second modified cell range extension equal to the second received cell range extension multiplied by the factor, wherein the factor is less than 1.